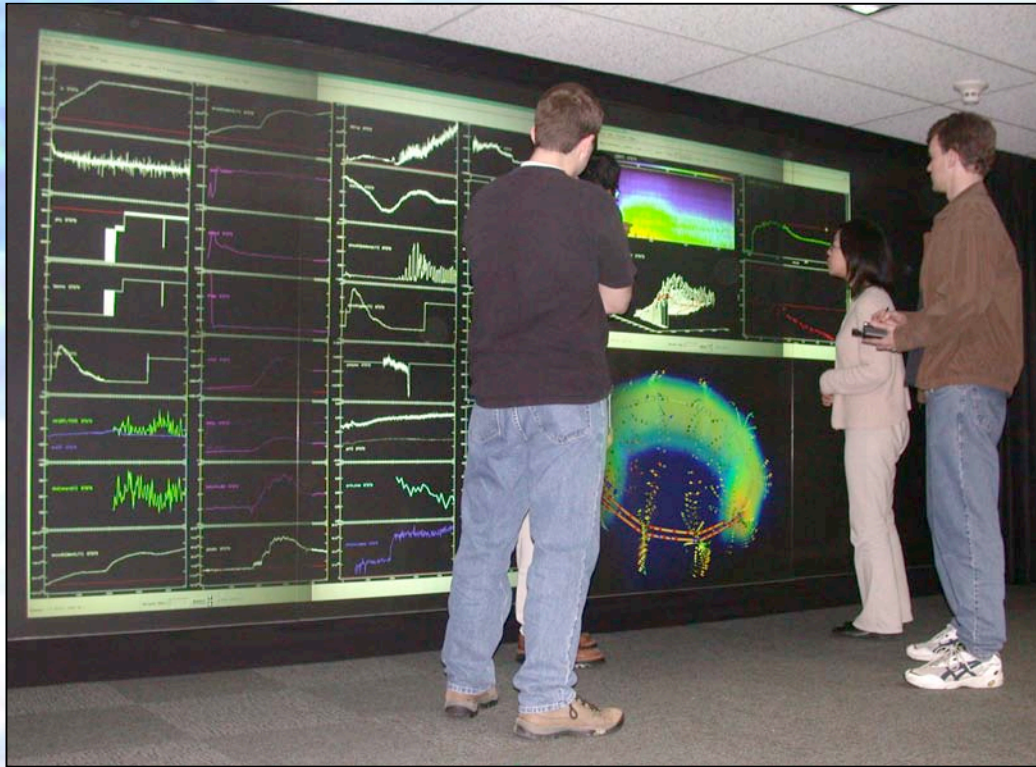


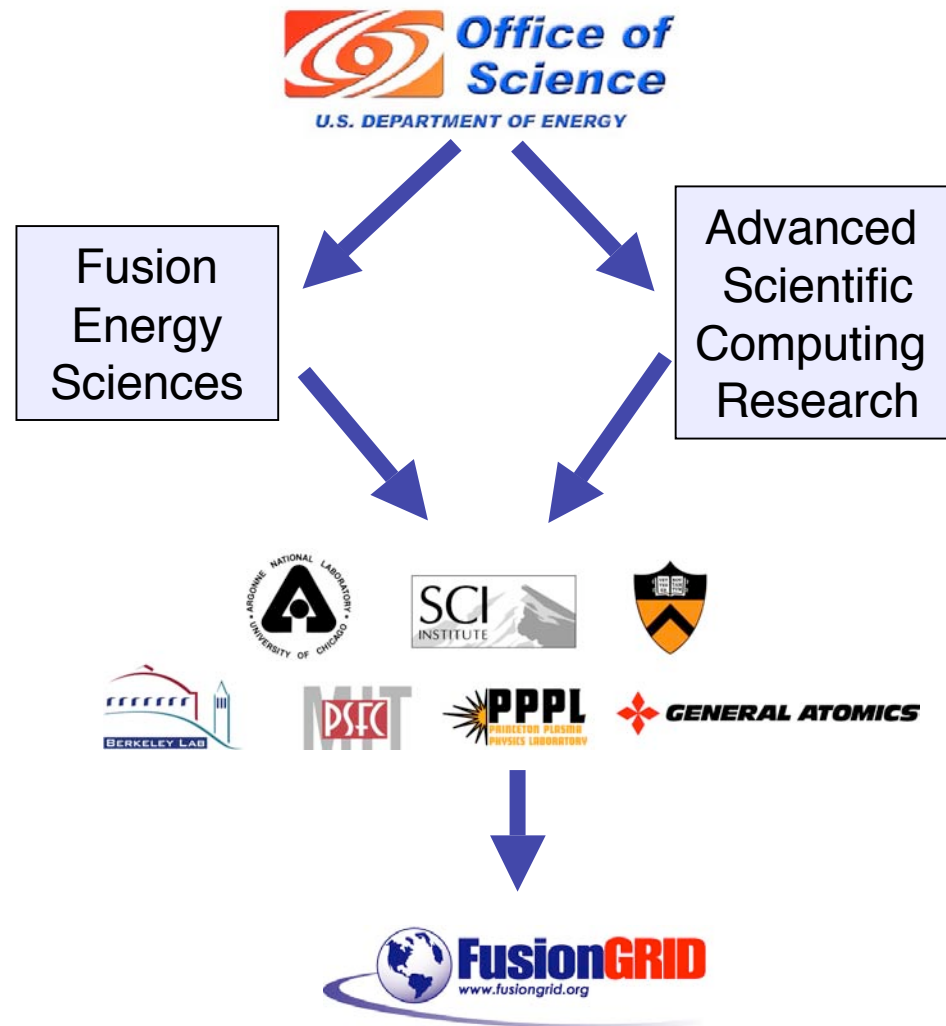
# THE NATIONAL FUSION COLLABORATORY PROJECT



David P. Schissel  
DIII-D National Fusion Facility  
General Atomics  
San Diego, CA

At the  
ITER-Grid Demonstrations  
Arlington, VA  
December 20, 2003

# COLLABORATORY'S GOAL IS TO ADVANCE SCIENTIFIC UNDERSTANDING & INNOVATION IN FUSION RESEARCH



# NATIONAL FUSION COLLABORATORY PROJECT SEEKS TO UNIFY SCIENTISTS ACROSS THE UNITED STATES



National Fusion Collaboratory

- Theory & Modeling

- Realistic non-linear 3D models

- 1500 U.S. scientists

- 90 sites, 37 states



- New work paradigm

- Experimental Facilities

- \$1B capital investment

# COLLABORATORY'S GOAL IS TO ADVANCE SCIENTIFIC UNDERSTANDING & INNOVATION IN FUSION RESEARCH

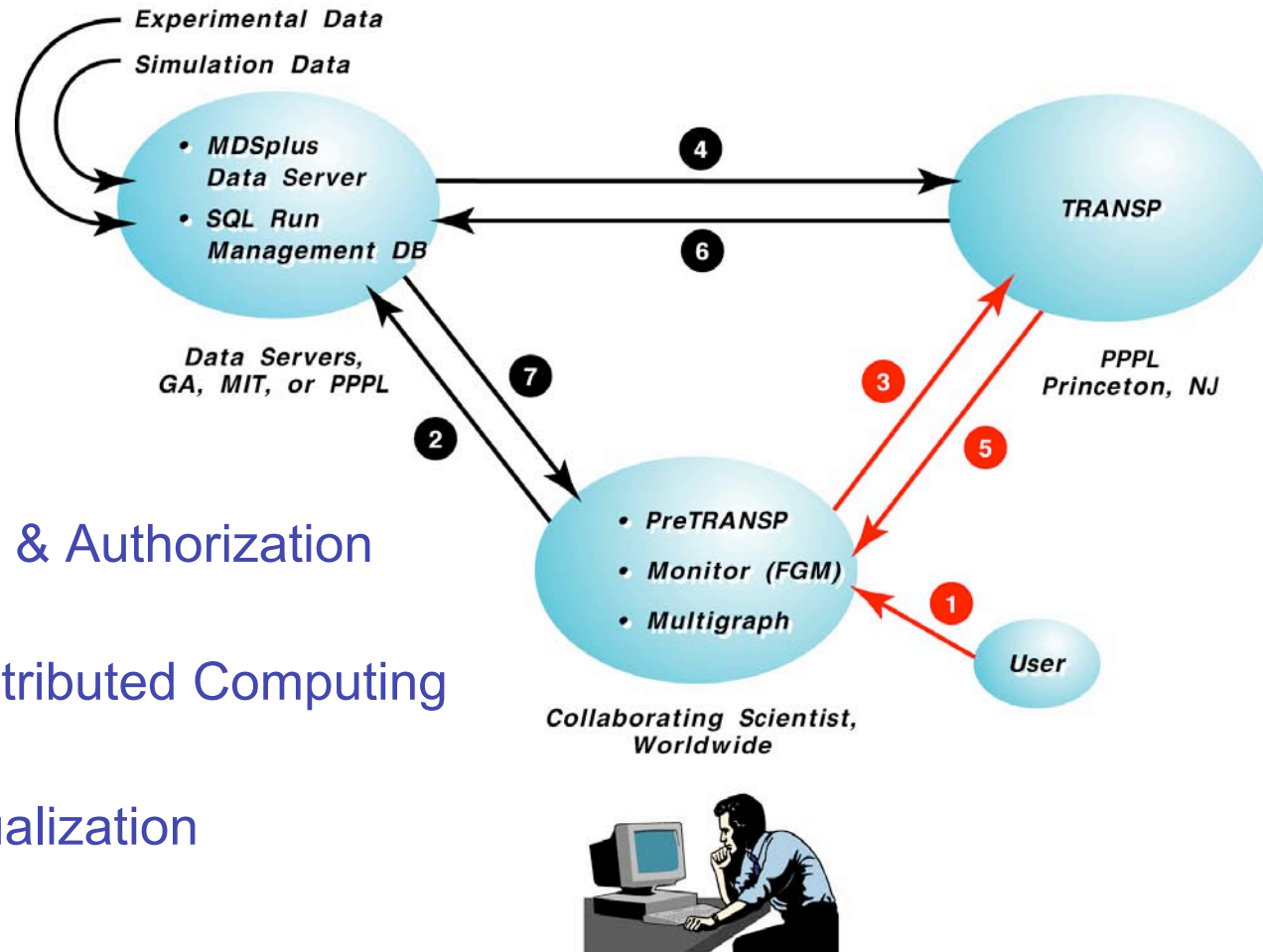
- Enable more efficient use of existing experimental facilities through more powerful between pulse data analysis resulting in a greater number of experiments at less cost
- Allowing more transparent access to analysis and simulation codes, data, and visualization tools, resulting in more researchers having having access to more resources
- Enable more effective integration of experiment, theory, & modeling
- Facilitate multi–institution collaborations



# NFC IS CREATING & DEPLOYING COLLABORATIVE SOFTWARE TOOLS FOR THE FUSION COMMUNITY

- Data, Codes, Analysis Routines, Visualization Tools should be thought of as network accessible services
  - Access is stressed rather than portability
- Shared security infrastructure: authentication & authorization
- Collaborative nature of research requires shared visualization applications and widely deployed collaboration technologies
  - Integrate geographically diverse groups
- Not focused on CPU cycle scavenging or “distributed” supercomputing (typical Grid justifications)
  - Optimize the most expensive resource - people’s time

# SUCCESSFUL GRID COMPUTING FOR FUSION SCIENCE

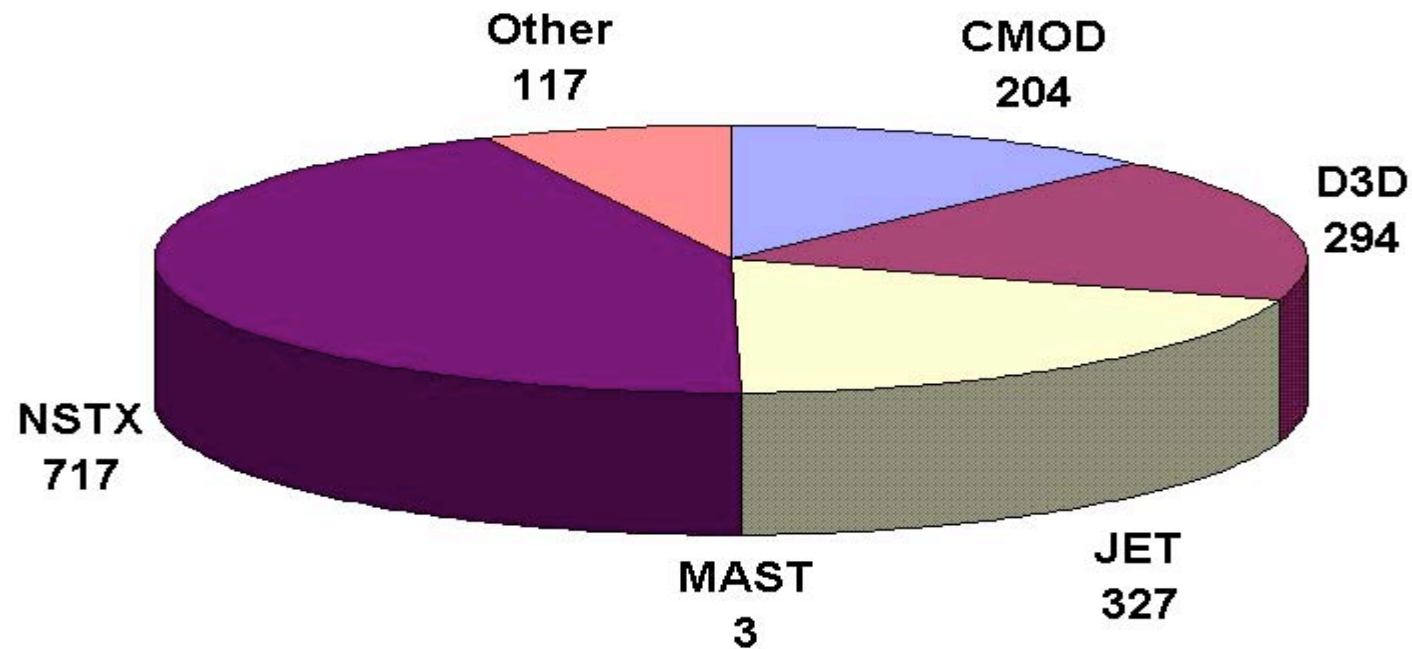


- Authentication & Authorization
- Remote & Distributed Computing
- Scientific Visualization

TRANSP – Tools for time dependent analysis & simulation of tokamak plasmas

# GRID COMPUTING FOR NUMEROUS TOKAMAKS

Total Runs in FY 2003: 1662



# SNAPSHOT OF GRID COMPUTING FROM WEDNESDAY

FGM (Fusion Grid Monitor) - Runs

Run ID	Code	User	Tokamak	State	Last Updated	Comments
<a href="#">42982C40</a>	TRANSP	budny	JET	Running	Wed Dec 17 12:24:45 PST 2003	Restart at 10.82 (sec) - cpu time = 0.3763 (hrs)
<a href="#">109070Z61</a>	TRANSP	leblanc	NSTX	Completed	Wed Dec 17 10:00:51 PST 2003	Completed on petrel011.pppl.gov on Wed Dec 17 13:00:33 EST 2003
<a href="#">08419C10</a>	TRANSP	pshare	MAST	Stopped	Wed Dec 17 06:54:21 PST 2003	Wed Dec 17 09:53:33 EST 2003: on petrel012.pppl.gov during runtrx_pre
<a href="#">99411O98</a>	TRANSP	peng	D3D	Completed	2003-12-16 05:54:46.0	Completed on transpcomp.pppl.gov on Mon Nov 17 22:33:02 EST 2003
<a href="#">84293U01</a>	TRANSP	murakami	D3D	Completed	2003-12-16 05:49:14.0	Completed on petrel014.pppl.gov on Tue Nov 25 02:12:19 EST 2003

Transferring data from nssrv1.gat.com...

FusionGrid transitioning to international usage

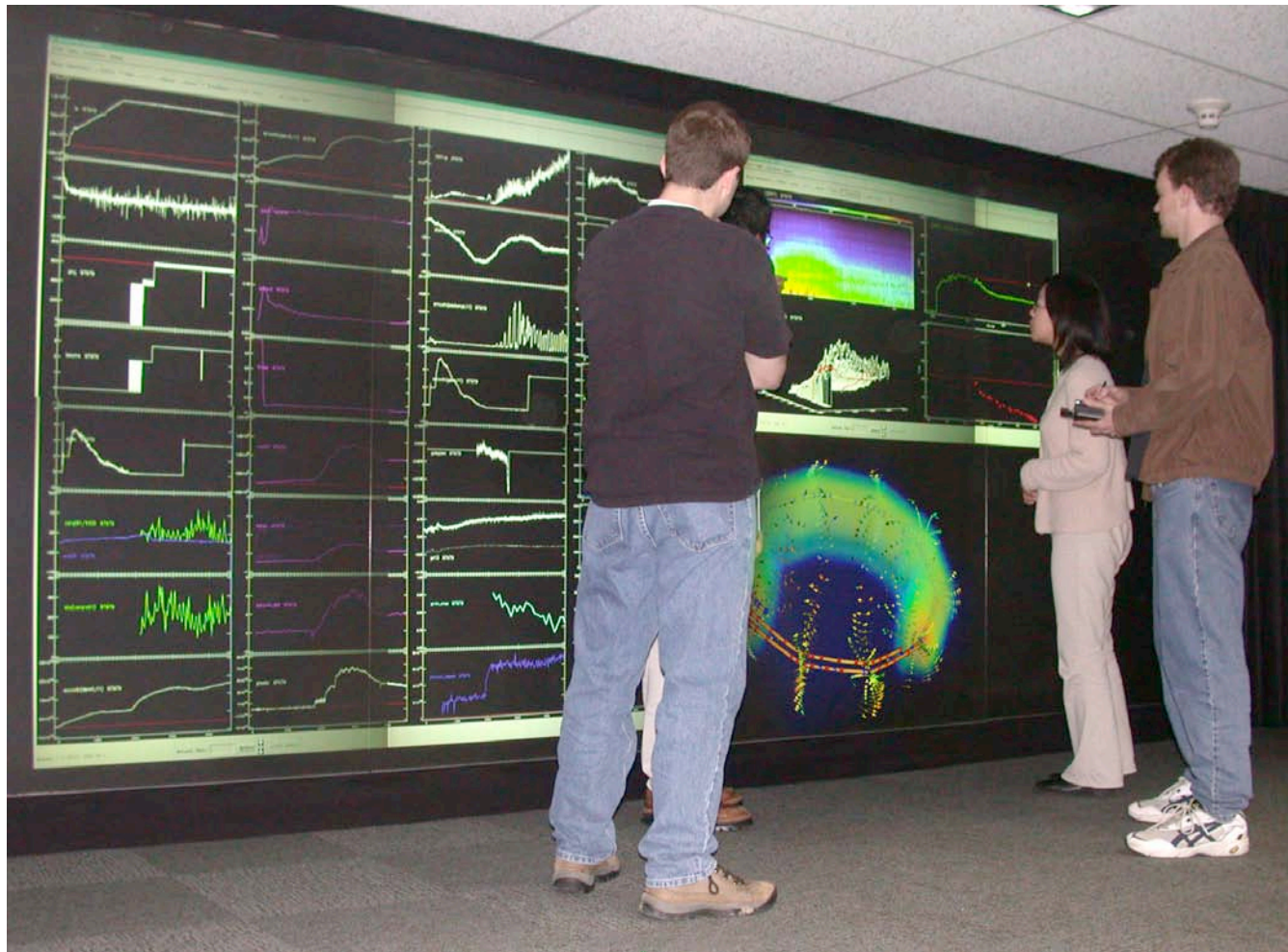


# COLLABORATIVE NATURE OF FES NECESSITATES A SHARED VISUALIZATION ENVIRONMENT

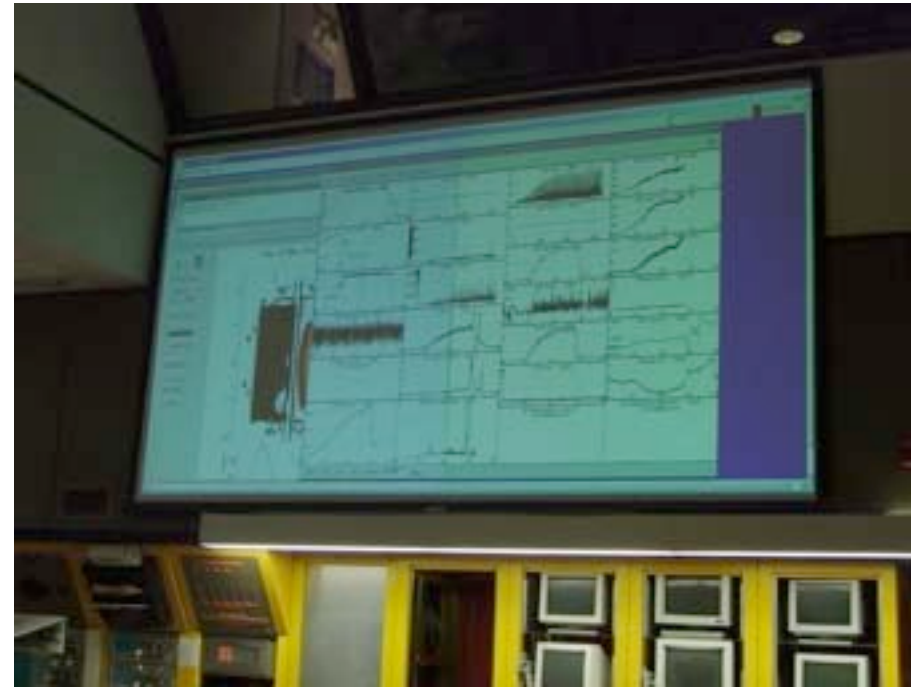
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- Strive to dramatically reduce the hurdles that presently exist for collaborative scientific visualization
- Collaborative or Virtual Control Room
  - Large on-site group interactively work with small to large off-site group
  - Just as rich an experience for off-site personnel
- Collaborative working or data analysis meetings
  - Simultaneous sharing of complex visualization
  - Critical for complex simulations

# TILED DISPLAY ALLOWS A LARGE GROUP TO EXPLORE INFORMATION IN COLLABORATION MORE EFFECTIVELY



# TILED DISPLAY WALL FOR FUSION CONTROL ROOM



**PROTOTYPED THIS YEAR, PERMANENT INSTALL EARLY NEXT YEAR**



# ACCESS GRID: REAL TIME COMPLEX COMMUNICATION



## Access Grid

- Audio & Video services
- Shared applications
- Small to very large meetings
- Grid enabled: secure

# EXPERIMENTAL SCIENCES PLACES A PREMIUM ON REAL-TIME ANALYSIS OF LARGE DATA

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- Pulsed Experiments: 10 s duration plasma every 20 min
- 20 to 40 people in control room plus remote collaborators
- 10,000 separate measurements per plasma
- Long term goal: what we do overnight we do between plasmas



Alcator C-Mod Control Room



DIII-D Control Room



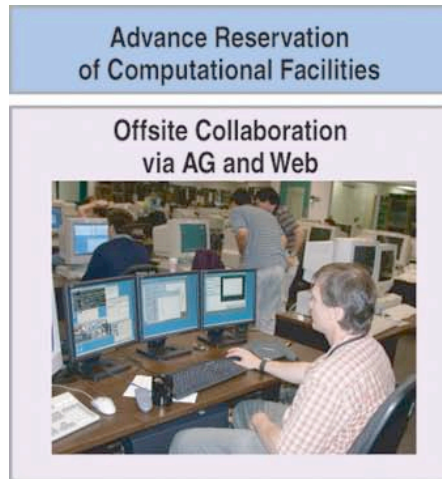
# CHARACTERISTICS OF A REMOTE CONTROL ROOM

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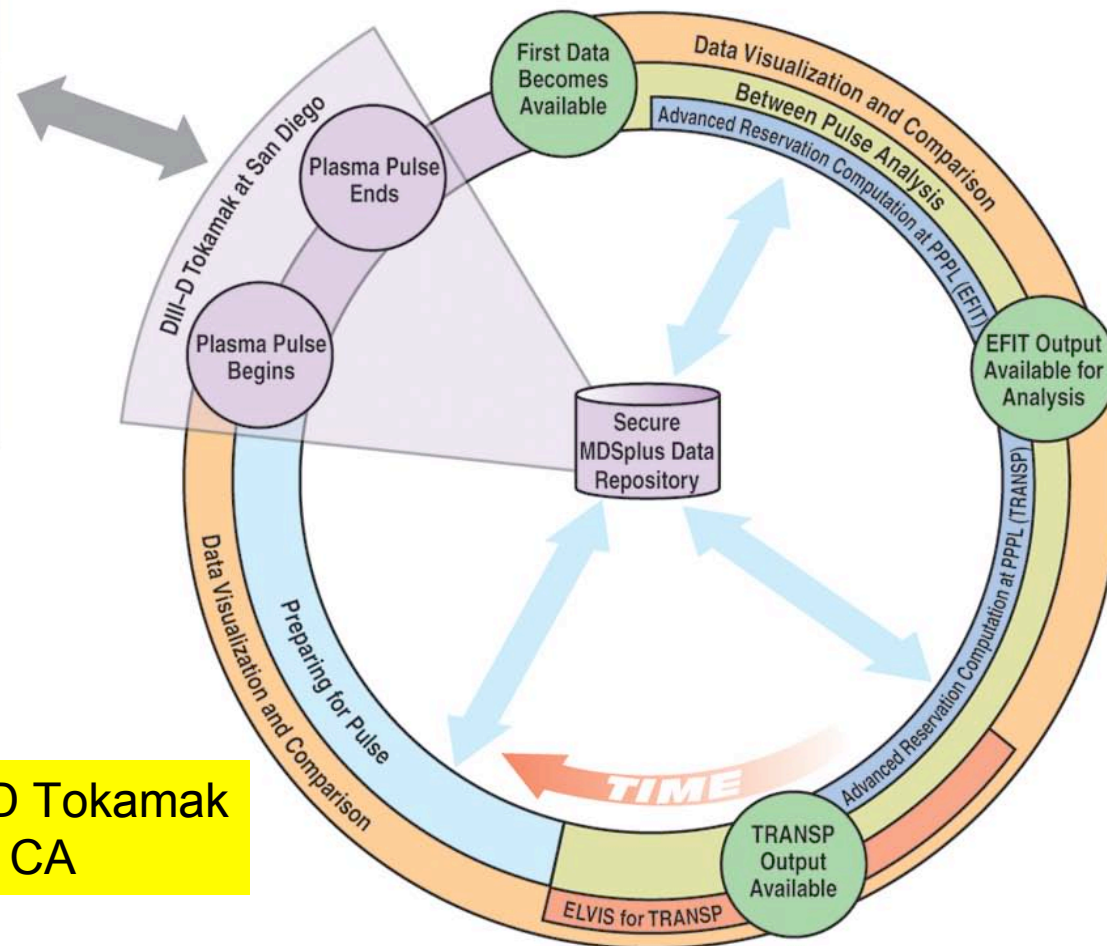
- As rich and as engaging experience if one is on-site
- Timely access to all data
  - No data analysis penalty for being off-site
- Involved in the decision making
  - Audio, video, and shared applications for discussion
- Advanced reservation of computing resources
  - Grid computing to support tokamak operations



# COLLABORATIVE CONTROL ROOM DEMONSTRATION: INTEGRATE OFF-SITE SCIENTIST INTO THE EXPERIMENT



Phoenix, AZ to DIII-D Tokamak  
in San Diego, CA



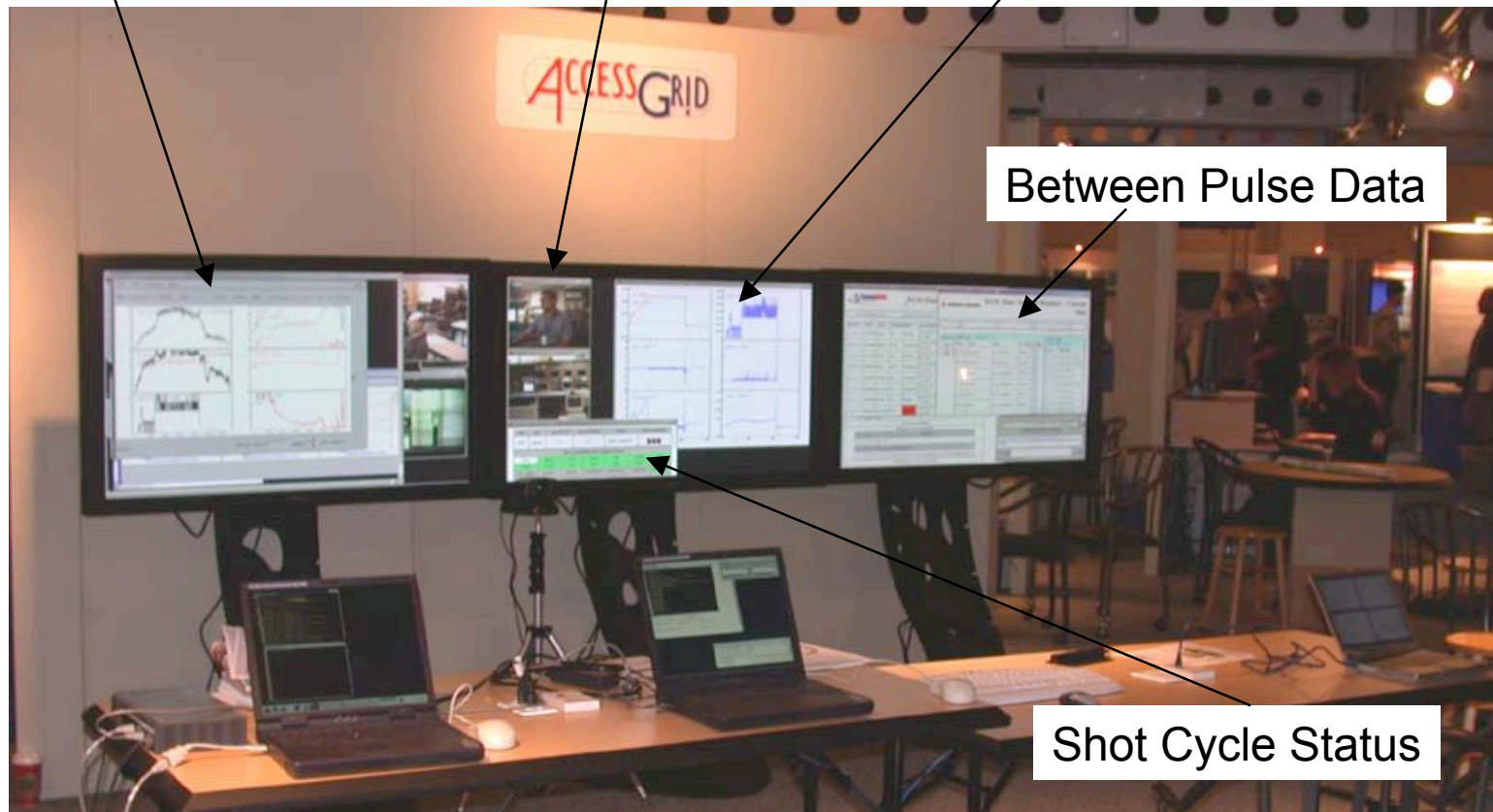
# REMOTE CONTROL ROOM DEMONSTRATION AT SUPERCOMPUTING MEETING NOVEMBER 2003

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Shared Application

Video & Audio

Real Time Data Display

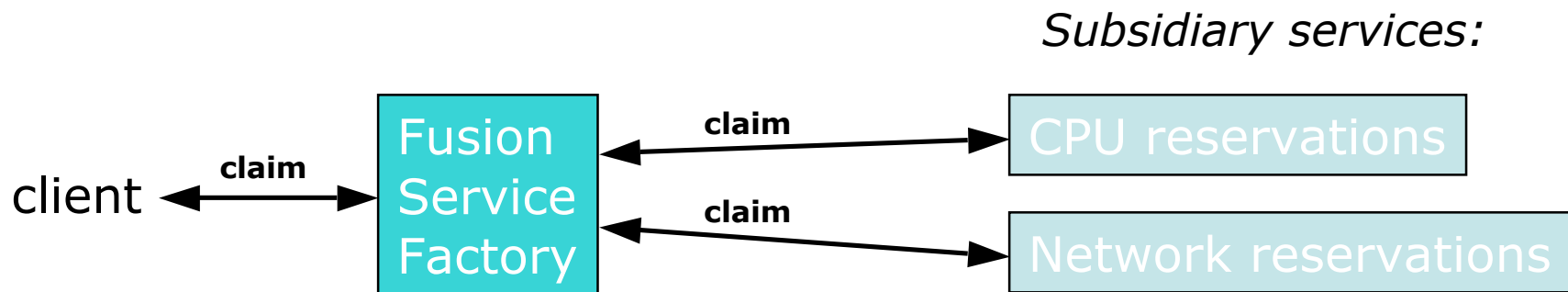


SuperComputing 2003, Phoenix AZ

# ADVANCE RESERVATION OF GRID SERVICE

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- Time bounded execution of remote analysis
  - Depends on multiple components (e.g. network, data, CPU)
- More efficient resource usage
- For our demonstration, calculate plasma shape
  - EFIT run on PPPL Linux cluster
  - Request so many time slices in a certain length of time





# AUDIO AND VIDEO FROM THE CONTROL ROOM

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- Moveable camera
  - “Look around” control room
- Multiple audio/video feeds
- For our demonstration, Access Grid
  - Many to one in control room



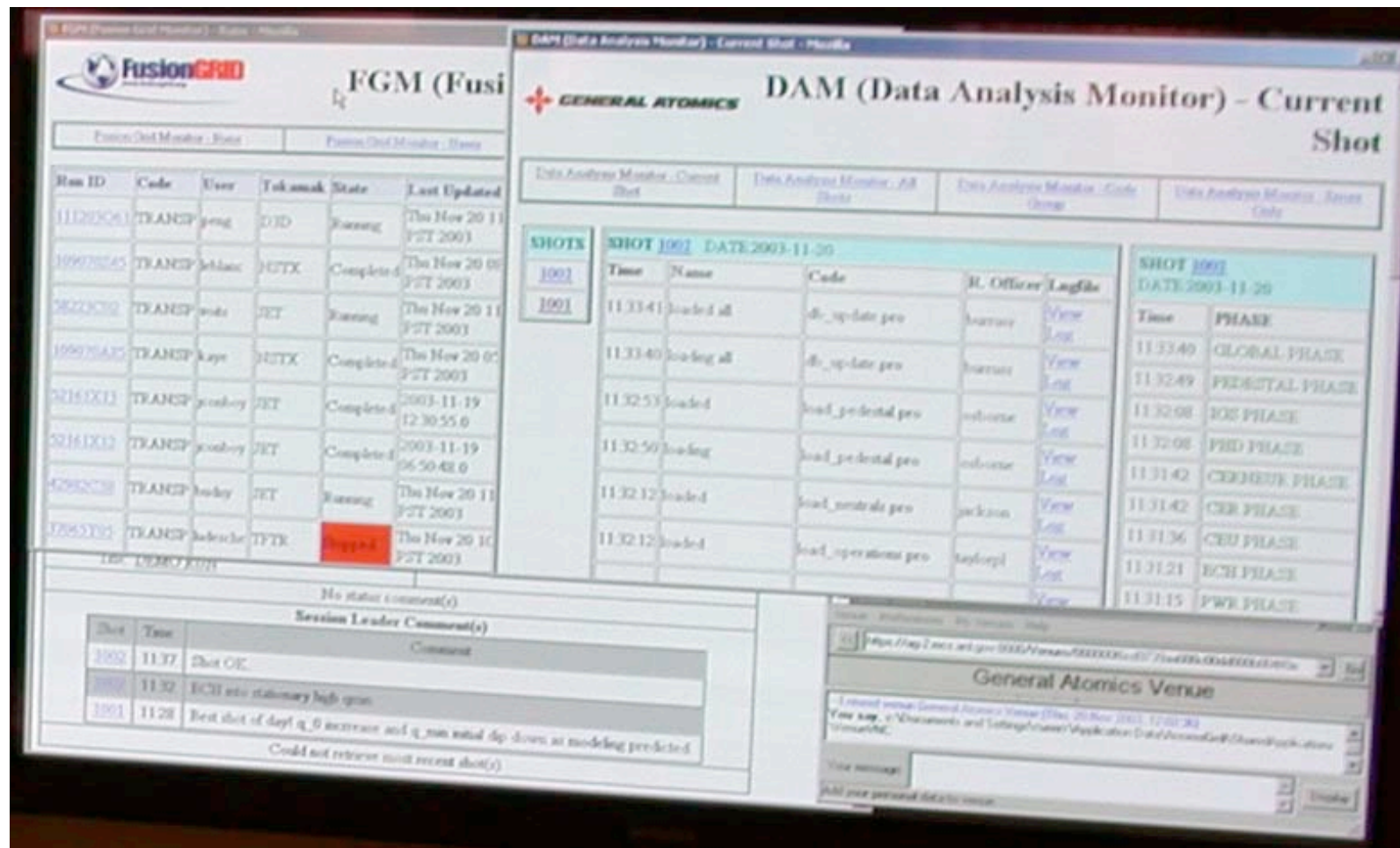
# PULSE CYCLE AND DATA ACQUISITION DISPLAY

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Remote Collaboration Requires a Sense of Presence in the Control Room

date	type	avg. IT (T)	avg. IP (MA)	status	time remaining	
2011	plasma	1.75	2.8	done complete	NNN	
Data Acquisition and Analysis Status						
2011	MAG	CO2	PCS	NB	NCV	SPV
PVE	NCTH	CO2	CO2	FE	PID	PVEP
PH. MAG	NCTH	NCTD	CEMUS	FEUCAL	TANSTY	PREDTAL

# ANALYSIS MONITORING AND ELECTRONIC LOGBOOK



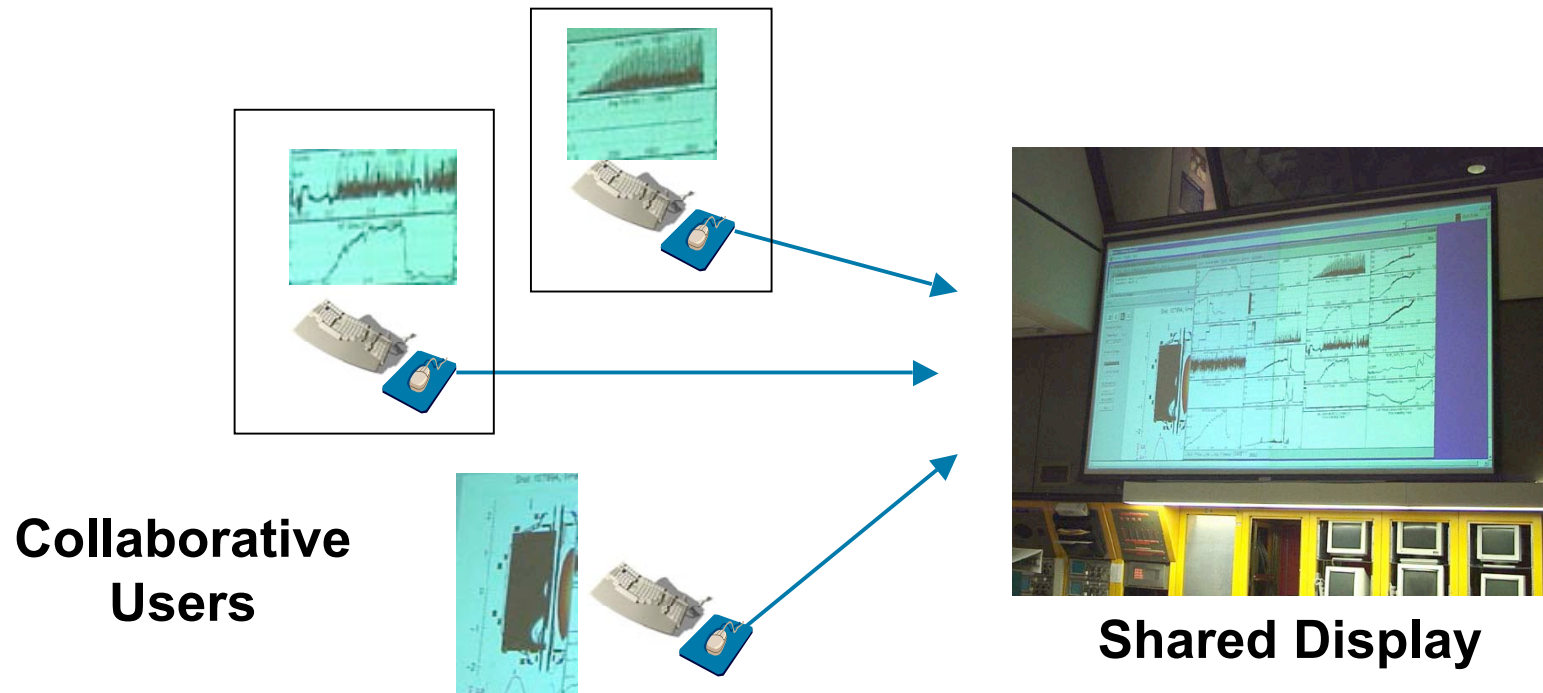
# REAL TIME DATA DISPLAY OF KEY PLASMA PARAMETERS

Sense of Presence



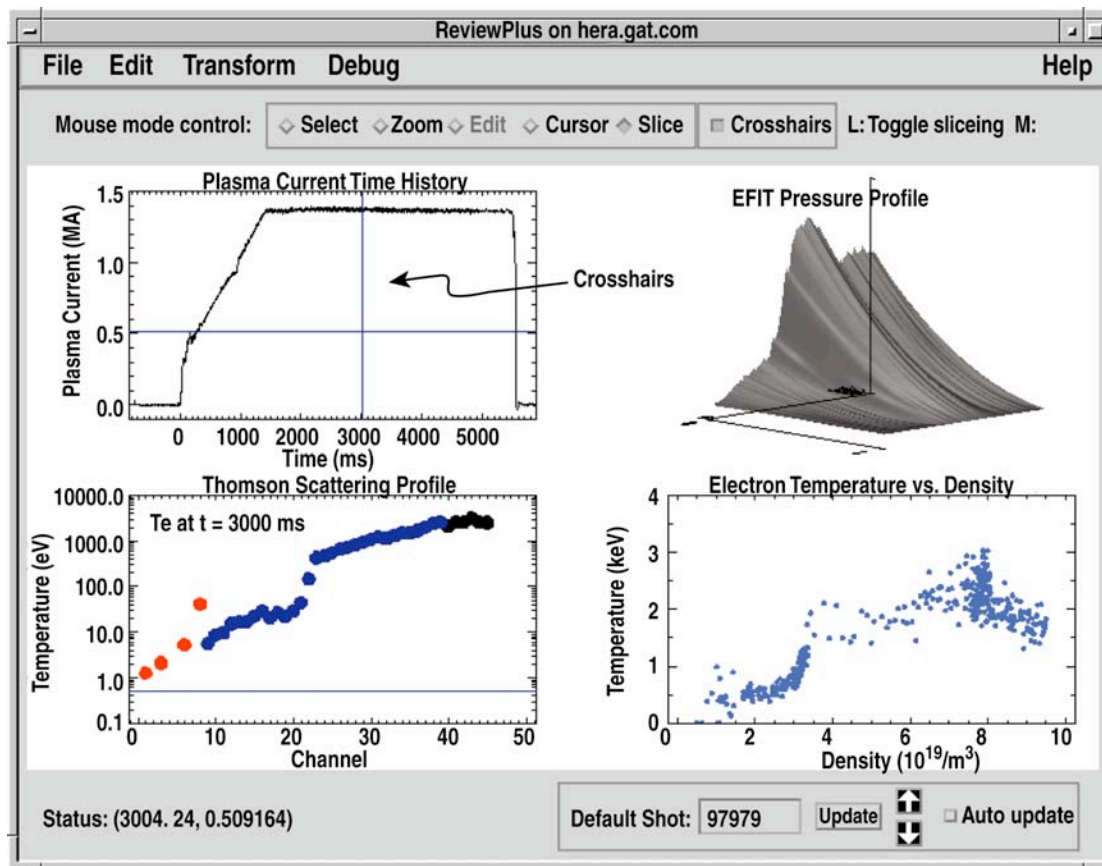
# APPLICATION SHARING AND CONCURRENT CONTROL WITHIN THE CONTROL ROOM

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- Demonstrated to the AG node
- Replaces paper or “bending over” terminal

# APPLICATION SHARING ALLOWS DETAILED DISCUSSION OF PHYSICS IN REAL TIME

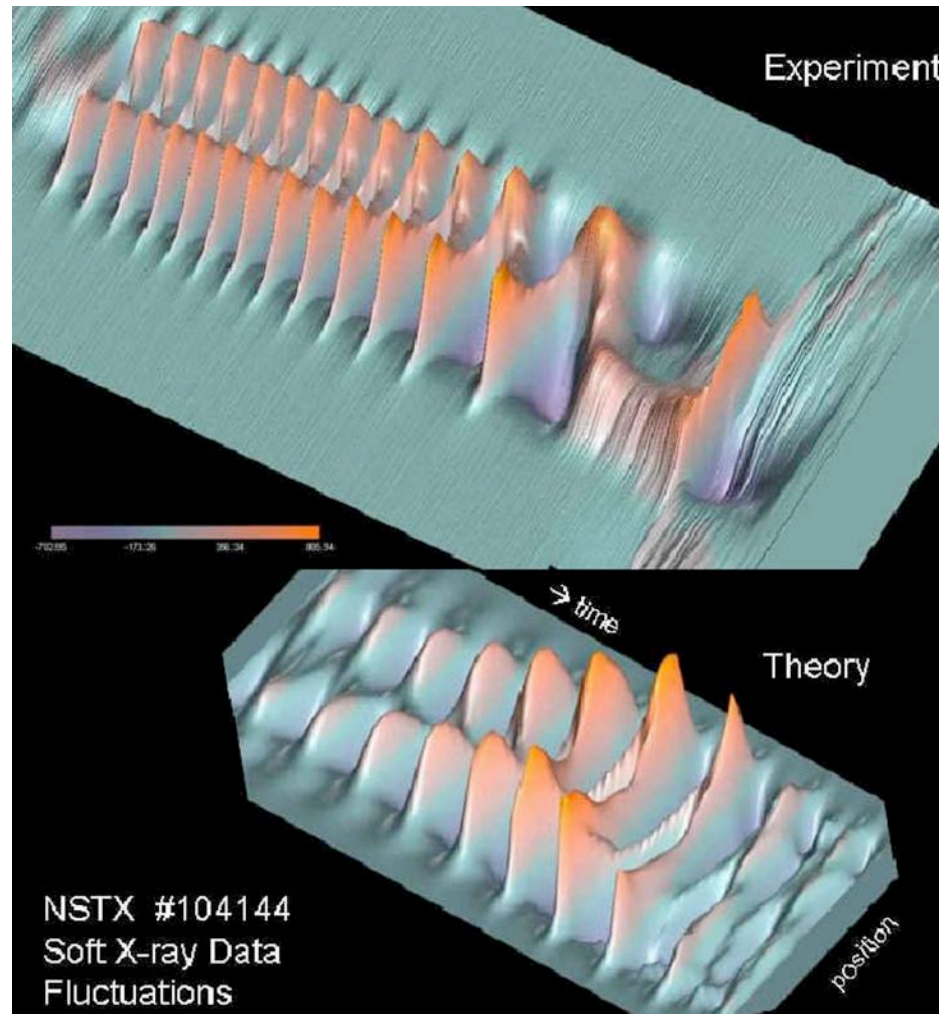


- For our demo, ReviewPlus  
— Data from San Diego
- Fully interactive
- Any application



# EXPERIMENTAL AND THEORETICAL COMPARISONS ARE CRITICAL TO UNDERSTANDING

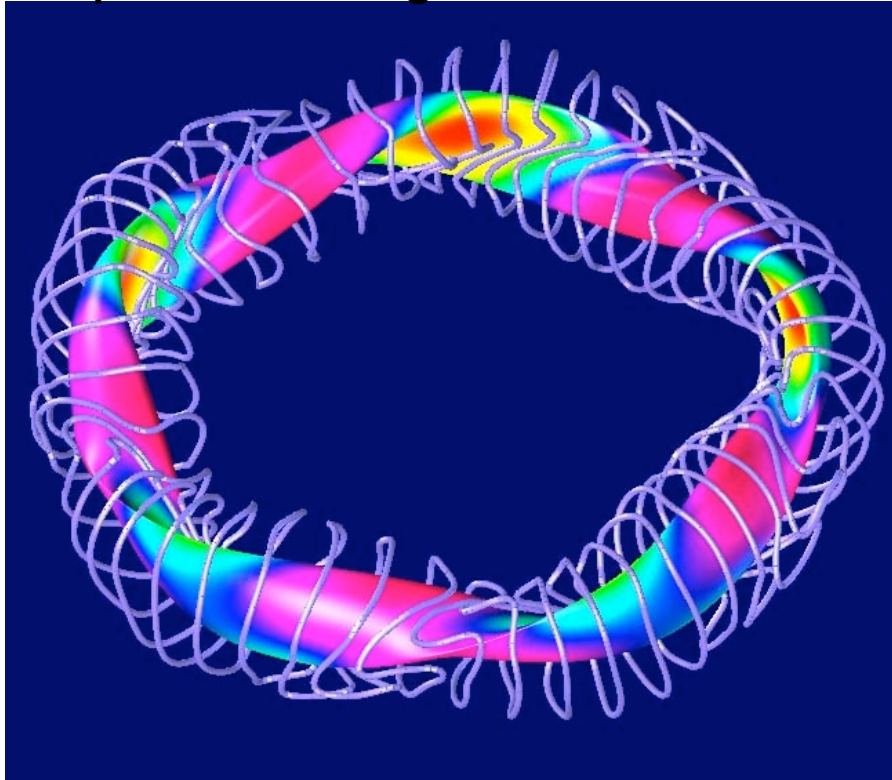
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# FES SIMULATIONS ARE VERY COMPLEX

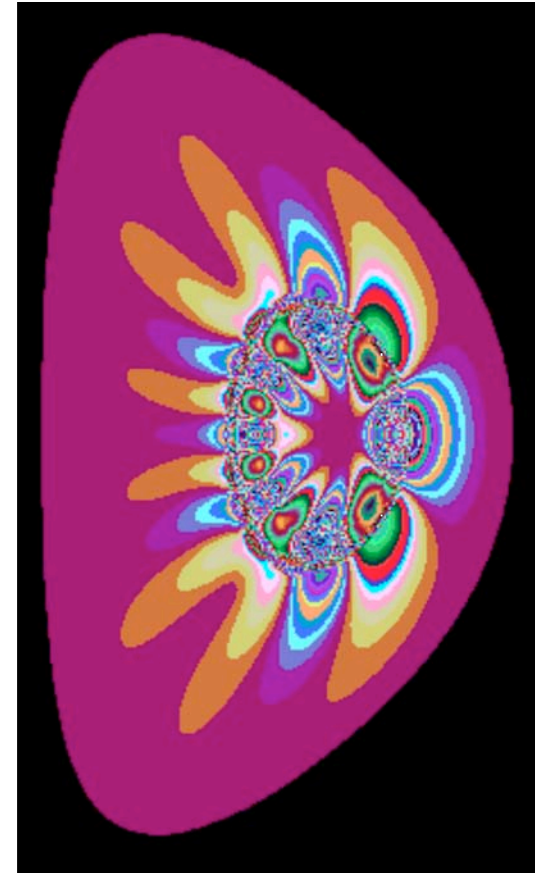
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**Experimental design simulation**

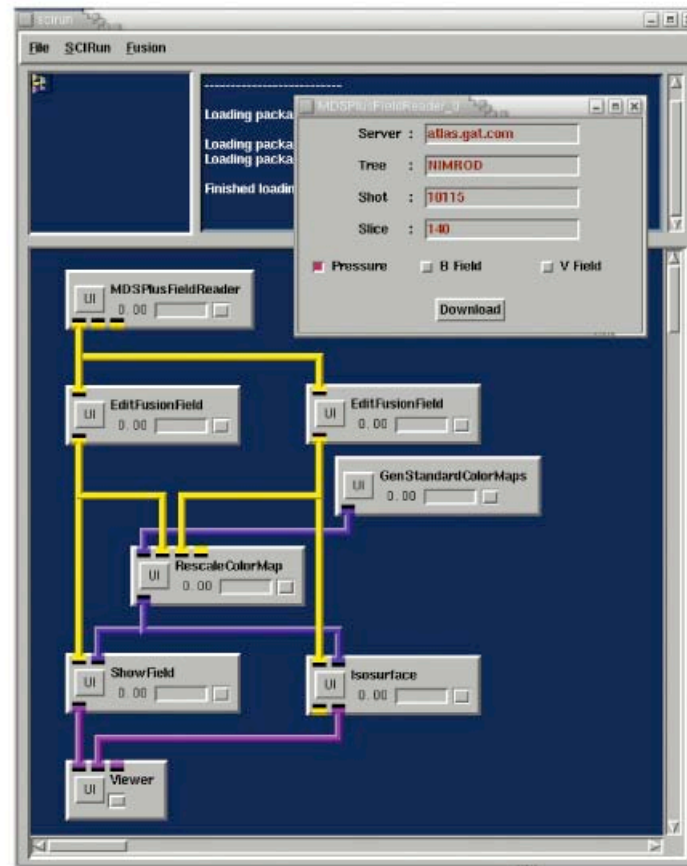
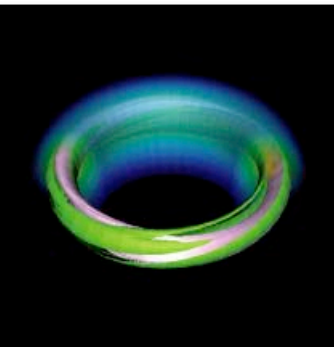
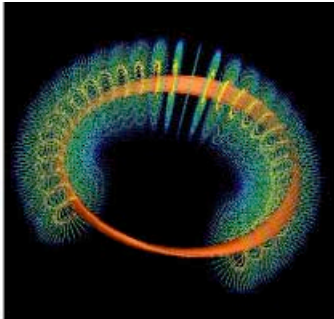


- 10 decade range in time and space
- Extreme anisotropy
- Interaction of fine and large scale physics

**Plasma stability simulation**



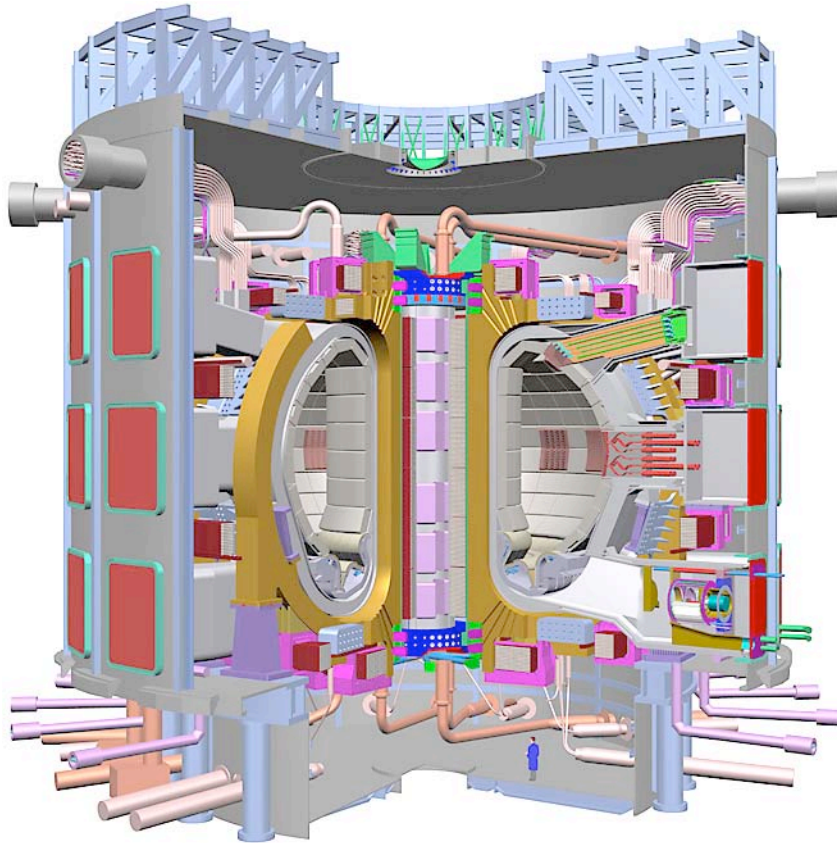
# COMPLEX SIMULATIONS REQUIRE ADVANCED VISUALIZATION FOR BETTER UNDERSTANDING



- Raises challenge of very large datasets
- Sharing critical
- Integrated into tokamak operations

# ITER: SUCCESSFUL OPERATION REQUIRES EFFECTIVE REMOTE COLLABORATION

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- Productive engaging work environment for off-site personnel
- Large simulations, shared visualization, decisions back to control room
- Policy is critical
  - Fast access to all data
- Timely prototyping of technology can assure ITER needs are met
  - ITER requires robust, proven systems